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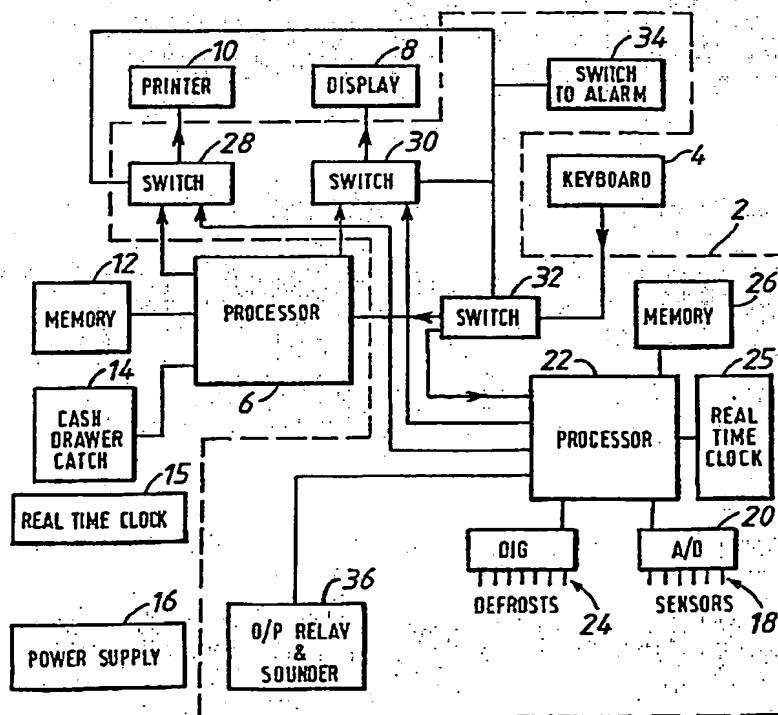
(56) Documents cited  
US 4482785 A

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UK CL (Edition K) G1N NADC NAHJ NAJX NARA  
INT CL<sup>6</sup> F25B, F25D, G01K  
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(54) Monitoring refrigeration units using other electronic apparatus

(57) The condition of one or more refrigerated units is monitored using sensing means which provides a signal indicative of a temperature condition of the or each unit, and a device having a primary function unrelated to the monitoring of refrigerated units and which includes at least a printer and a power supply circuit developing the voltage or voltages needed for its primary function. The device may be an electronic cash register, an electronic weighing scale, an integrated retail check-out counter or a facsimile machine. Additional circuitry 2 which can be incorporated in the device, causes the device to operate in a refrigeration information output mode in which the printer prints information derived from the signal or signals from the sensing means.

FIG.1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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FIG. 1

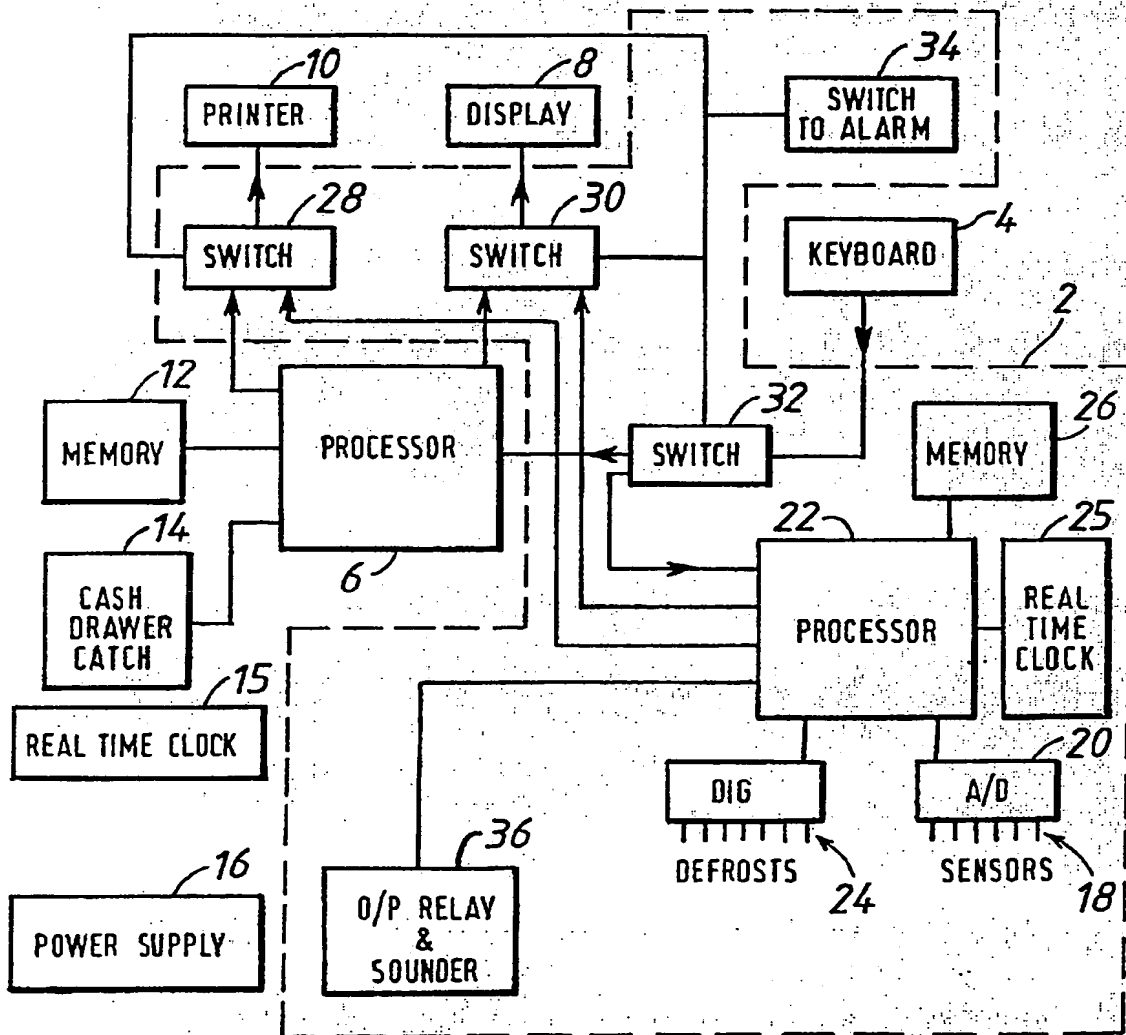
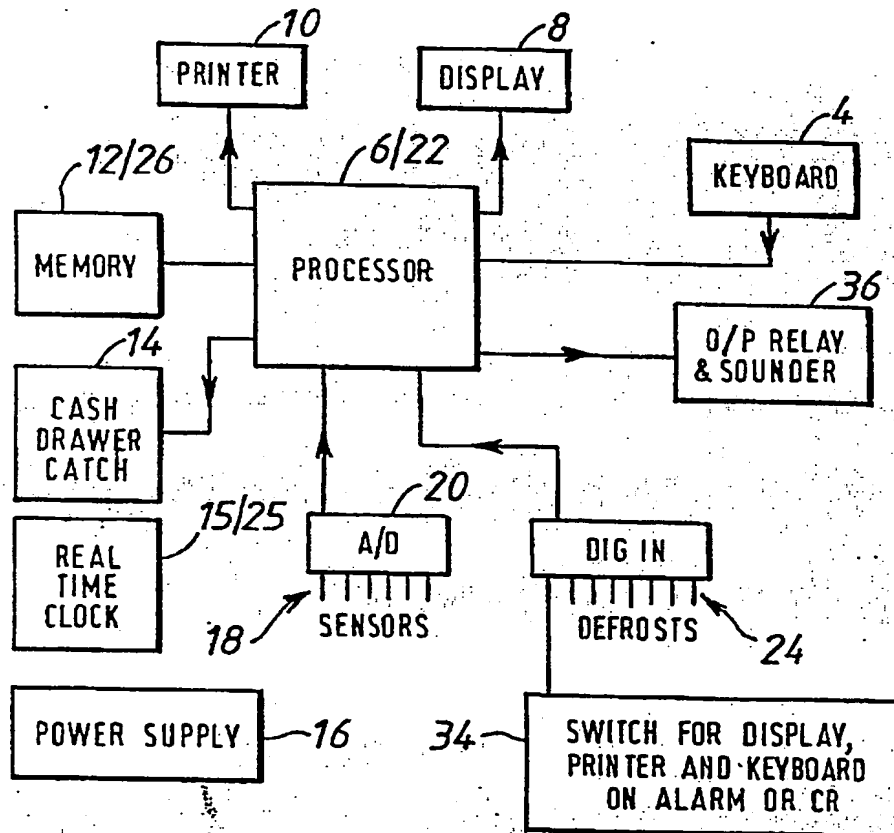


FIG. 2



MONITORING REFRIGERATED UNITS

This invention relates to a system for monitoring the condition of one or more refrigerated units.

Supermarkets normally have large numbers of refrigerated units for keeping foodstuffs at reduced temperatures. It is known for a monitoring system to be provided which senses the condition of each cabinet, maintains a log indicating the condition of each cabinet at regular intervals, and activates some kind of alarm when the condition of any one of the cabinets is such that it is likely the foodstuff in it will rise to an unacceptably high temperature.

The alarm may be in many different forms, for example simply an audible alarm, a light, the activation of a taped telephoned message, or some other type of alarm which will attract the attention of a person in the vicinity, or located remotely at a time when the supermarket is closed, to the potentially unsatisfactory situation. In the United Kingdom there is now a requirement for any shop having one or more refrigerated units to have facilities for monitoring the condition of those units. However, the cost of the type of equipment used in supermarkets would be excessive for a shop having relatively few refrigerated units.

The invention aims to provide a system for monitoring the condition of one or more refrigerated units at moderate cost.

The invention arises from a realisation that even  
5 small shops virtually always have an electronic cash register, often have an electronic weigh scale, or an integrated retail check-out counter (IRCOC) and sometimes have a facsimile machine, and that devices of this kind, the function of which is not related to  
10 monitoring refrigeration units, nevertheless contain technical features which can be made use of as part of a refrigerated unit monitoring system, thus reducing the cost of installation of such a system.

The invention provides a system for monitoring  
15 the condition of one or more refrigerated units, comprising sensing means adapted to provide a signal indicative of a temperature condition of the or each unit, a device having a primary function unrelated to the monitoring of refrigerated units, said device  
20 including at least a printer and a power supply circuit for developing the voltage or voltages needed for its primary function, and means for causing said device to be operable in a refrigeration information output mode in which the printer can print  
25 information derived from the signal or signals from the sensing means.

The term "temperature condition" is used throughout this specification to encompass any parameter having a relationship to the temperature of foodstuffs contained in the type of refrigerated unit involved, for example the air temperature in an enclosed chest-type unit, the temperature of air circulating towards the evaporator, or leaving the evaporator in an open-fronted type of unit, or a function of both those temperatures, or temperature as sensed by a sensor actually placed among foodstuffs within a refrigerated unit. The important thing is the temperature of the foodstuffs themselves but it is not practical normally to measure this directly and so usually it is inferred from some indirect measurement such as those just indicated.

There is a further advantage in inferring the product temperature from the air temperatures: this is that the temperature inertia of the foodstuff means that the air temperatures are predictive; consequently using air temperatures for sensing alarm conditions allows the operator to take remedial action before the food rises to an unacceptable temperature.

As mentioned, various types of devices which may be found in shops can be utilised in a system in accordance with the invention, provided that they incorporate a printer which in the refrigeration

information output mode will print a log of information derived from the sensing means, for each refrigerated unit, and a power supply which of course will already be adapted for operation of the printer  
5 when the device is connected to the electricity mains.

It will become apparent that additional valuable functions can be performed when the device employed has other facilities within it such as a digital processor, memory, a real time clock, a display or a  
10 keyboard. In general, the more of these facilities are available within the device, the less have to be provided at additional cost for the purpose of creating a temperature monitoring system for the refrigerated units.

15 An electronic cash register is the favoured device because it will almost always have all of the facilities just mentioned, and also almost every shop is already equipped with one.

In order that the invention will be more clearly  
20 understood, embodiments thereof will now be described with reference to the accompanying diagrammatic drawings, in which:

Figure 1 shows in block diagram form an existing common type of cash register which has been equipped  
25 for the purpose of the invention with add-on auxiliary circuitry; and

Figure 2 shows a cash register of modified design such that the facilities for the temperature monitoring function are built in at the manufacturing stage.

5 In Figure 1 the components outside the broken-line box 2 are the components of a normal cash register. Those within the box 2 are additional components of auxiliary circuitry which can be retrofitted to an existing cash register to adapt it for  
10 temperature monitoring in accordance with the invention, these being provided for example on one or more extra printed circuit boards which can be fitted within the casing of the cash register.

The unmodified cash register includes a keyboard  
15 4 on which the components of a sale are entered item-by-item, a processor 6 which can calculate the total value when instructed from the keyboard 4, a display 8 on which the item values and the total values can be displayed under the control of the processor, a real  
20 time clock 15, and a printer 10 which prints the time, the individual items and the total, again under the control of the processor. A memory 12 contains the program needed to run the processor and values, such as sub-totals, being collected. The cash register  
25 will also include a cash drawer, the catch 14 of which is released by the processor in response to



instructions from the keyboard 4. Additionally, there is a power supply 16 which derives from mains power the appropriate voltages required to operate the various electronic and electrical components of the cash register.

The auxiliary circuitry shown within box 2 comprises analogue inputs 18 for receiving signals indicative of temperature conditions from sensing means which senses the temperatures of each of one or more refrigerated units, an analogue-to-digital converter 20 for converting the signals to digital form in which they can be processed by a processor 22, a set of digital inputs 24 each for receiving a high or low signal which is indicative, for a respective refrigerated unit, of whether or not that unit is presently in a defrost cycle, in which case any temperature information from it should be disregarded, the digital inputs 24 also being connected to the processor 22, a memory 26 for storing the program to run the processor and, under the control of processor 22, information which has been received from the inputs 18 and 24 over a substantial period of time, a real time clock 25 to time and date stamp the information records, three electronic switches 28, 30 and 32, a manual switch 34 which is used to switch the cash register between its normal cash register mode of

operation, and a refrigeration information output mode of operation in accordance with the invention, and an alarm output facility 36 which may simply be a relay which when activated may cause operation of an audible alarm, of a telephone message sending machine, of warning lights or of any other kind of alarm, and which may also incorporate an audible alarm within or on the outside of the cash register.

It should be noted that the temperature monitoring functions, which lead to alarm activation when necessary, and the temperature logging functions are active at all times, that is to say, temperature conditions are checked against alarm limits constantly and the alarm activated whenever necessary, and temperature conditions are logged or memorised from time to time (e.g. once per hour) for the eventual printing out of a log, both being done while the cash register remains operable as such. The functions which are controlled by switch 34 are the display of the logged temperatures, the printing of the logged temperatures, the keyboard control of the display, the printer, the processor and other components of the system.

When switch 34 is actuated, it in turn operates switches 28, 30 and 32, so that the keyboard 4, display 8 and printer 10 are placed in communication

with the auxiliary processor 22 and memory 26 instead of the cash register processor 6 and memory 12.

When the system is switched to this refrigeration information output mode, the keyboard 4 can be used to  
5 instruct the processor 22 to extract from memory 26 the data representing the temperature condition history of all the cabinets over the most recent period of time, and to deliver this data for printing by the printer 10. The keyboard 4 can also be used to  
10 instruct the processor to cause any selected information from within memory 26 to be displayed on the display 8 such as present alarm limits and delay times, which are explained below.

The program necessary to enable these functions  
15 to be performed is well within the capacity of the skilled programmer and the exact nature of the functions required and exactly what is to be logged and exactly what is to be available for display can readily be decided by those skilled in refrigeration  
20 control and monitoring system. Accordingly, those details do not in themselves form part of the present invention.

A particular system in accordance with the invention is set up to monitor seven refrigerated  
25 units of the open-fronted type, where air is blown over an evaporator in the rear of the unit to be

cooled, is then fed downwardly across the front of the unit in the form of a cold air curtain, and then drawn back in to be recirculated back to the evaporator. The sensing means is of a known type comprising and  
5 "air-on" temperature sensor which senses the temperature of air going towards the evaporator and a "air-off" sensor sensing temperature of air leaving the evaporator. Each unit has an automatic defrosting facility which occasionally causes the evaporator to  
10 be temporarily warmed and has a defrost output at which a two-state signal is given to indicate whether or not that unit is presently defrosting.

The A/D converter 20 has 16 channels. Seven of them receive the signals indicative of the air-on  
15 temperatures of the seven units, seven more receive the signals indicative of the air-off temperatures of the seven units, and a further one receives a connection which branches seven ways to each of the seven units and which at each unit terminates in a  
20 socket used for calibration, as will be described below. Seven digital inputs 24 are used, one for receiving the two-state signal from a respective one of each of the seven refrigerated units.

When the switch 34 is in its normal position, the  
25 cash register will operate as such, with the printer, display and keyboard interacting with the processor 6

and memory 12, but the power supply 16 will be supplying not only the cash register components but also the components of the auxiliary unit 2 so that this unit can carry out its temperature monitoring function at the same time.

United Kingdom law requires the logging of "product temperature". The United Kingdom recommended practice for the calculation of "computed product temperature" (CPT), which is the variable recommended for logging, is  $X\%$  of the air-on temperature plus  $(100-X)\%$  of the air-off temperature. This is intended to represent approximately, or be a prediction of, the actual temperature of product in the particular refrigerated unit involved. The term "product temperature" for the purpose of this specification is not intended to be limited to that particular algorithm but is intended to encompass any value which is utilised as a representation of the approximate temperature of product in the refrigerated unit.

The processor 22 cyclically samples the air-on and air-off temperatures of each of the seven refrigerated units as presented at the inputs 18, and for each unit calculates the product temperature in accordance with the above, or a different, algorithm, the resulting value being stored in memory 26. For a particular unit, when there is a defrost signal

present at the appropriate digital input 24 and for a period thereafter, the temperature information from that unit is disregarded since it is known that it will not be useful.

5        When it is desired to print out a log of the product temperatures of the cabinets, switch 34 is switched to the refrigeration information output mode and the keyboard 4 is operated to instruct the processor 22 to control the printer 10 such as to  
10        print out a log of that information utilising the contents of memory 26. The switch 34 may also be moved to this position for the purpose of providing a display of the current values of the product temperatures of the refrigerated units, the  
15        appropriate instructions as regards which unit's temperature should be displayed again being entered through keyboard 4 and the information being derived by processor 22 from memory 26.

         It is normally preferable for an alarm condition  
20        to be recognised from an unacceptable variation in either the air-on temperature or the air-off temperature, or both by means of a CPT or similar algorithm, rather than a direct measurement of product temperature. This is because the air temperatures  
25        will change well in advance (perhaps by as much as two hours) of the temperature of the product itself owing

the thermal inertia of the product. This enables corrective action to be taken before the product itself has risen to an unacceptable temperature. It should be noted that an alarm level temperature has to  
5 be present for a set amount of time, called the delay time, before alarm action is activated.

For each refrigerated unit, an alarm threshold for air-on temperature or air-off temperature or a combination of both and a delay time, can be sent into  
10 the memory 26 from keyboard 4 when switch 34 is in the refrigeration information output mode, and the processor 22 then continuously compares the temperature measurements from each of the cabinets with its threshold. When any one of the temperature  
15 measurements exceeds its threshold for a period exceeding its set delay time, the processor 22 operates alarm output 36 which as mentioned can be connected to activate any type of alarm such as an audible alarm, lights, or an automatic-dialling system  
20 to send a pre-recorded message to a predetermined destination. The alarm output 34 may incorporate or be associated with an audible alarm which is inside or on the casing of the cash register so that an alarm is always given on the spot.

25 It has been mentioned that each refrigerated unit is provided with a socket for calibration purposes and

the sockets of all the units are in common connected to one of the analogue inputs 18. Periodically, a temperature probe is placed among the product contained in each unit (but one unit at a time) and  
5 plugged into the calibration socket of that unit. This provides to the processor 22 a signal indicative of the actual product temperature in the unit in question. By operation of keyboard 4, a historic log of the temperature of the product itself (as measured  
10 directly during calibration), air-on temperature, air-off temperature and CPT can be produced on the printer 10. Value X of the CPT algorithm can be modified using the keyboard 4 and the new historic log, with the new CPT produced. In this way, the value of X,  
15 which provides the most accurate result, can be established. This calibration should be carried out for each of the units from time to time to ensure correct operation of the system.

The programming required to enable the auxiliary  
20 circuit in box 2 to carry out the functions described can readily be prepared by one skilled in the art from the information given above.

Figure 2 shows how the components and functions of a refrigerated unit monitoring system can be built  
25 into a cash register at the manufacturing stage. The same reference numerals have been used as in Figure 1.



It can be seen that here the functions of memories 12 and 26 are combined in a single memory 12/26 and the functions of processors 6 and 22 are combined in a single processor 6/22, and the functions of real time clocks 15 and 25 are combined in a single real time clock 15/25, the additional components above and beyond those of a normal cash register then being only components 18, 24, 34 and 36. Switch 34 in this example provides digital signals to one of the digital inputs 24, which instruct the processor 6/22 to operate either in the cash register mode or in the refrigeration conditions output mode, depending on the position of the switch.

Equipping a plurality of refrigerated units with a monitoring system in accordance with the invention may involve providing special air-on and air-off temperature sensors within the units for the purpose of provided temperature information for operation of the monitoring system.

However, some refrigerated units are provided each with its own individual controller, which has its own air-on and air-off temperature sensors already fitted within the unit. In that case, the outputs from those temperature sensors can be utilised in the monitoring system of the present invention.

Some refrigerated unit controllers are

additionally able to carry out their own "product temperature" calculation, and have internal facilities for recognising the occurrence of an alarm condition. Where these more sophisticated controllers are  
5 provided on the refrigerated units, a standard communications interface can be used to link each of the controllers to the cash register and the auxiliary circuitry in the cash register can be simplified because it will not be required to calculate product  
10 temperatures, this having been done at the units themselves, and neither will it be required to recognise alarm conditions, because this will also be done at the units themselves. The signals generated at the individual units in response to alarm  
15 conditions can be used directly via the communications interface to activate the alarm output facilities of the cash register.

Additionally, where these more sophisticated controllers, with communication interfaces, are used,  
20 the set points necessary, such as defrost times and required superheat, within the controllers, can be altered from the keyboard 4 when the programming is designed to provide a control parameter alteration mode. The set points can also be displayed and  
25 printed.

All IRCOCs incorporate a processor, memory,

keyboard, display and printer and therefore also can be adapted in a similar manner to the cash registers described above, to form important parts of a refrigerated unit temperature monitoring system in accordance with the invention.

Electronic weigh scales normally have an A/D converter, a processor, a memory, a keyboard and a display and those which additionally have a printer can also be adapted for use in the invention. Those without a printer may also be similarly adapted, but a printer will have to be provided as an extra auxiliary unit.

Facsimile machines have a processor, a memory, a keyboard and a printer and some of them have a display. They also may be adapted to form part of a system in accordance with the invention though those without a display will preferably have one provided as an auxiliary unit. Facsimile machines also have an outward telephone dialling facility and so are particularly well suited for use in monitoring systems in accordance with the invention where the alarm is to include an outward telephone call.

Of course, each of the above types of device not in itself designed for use in temperature monitoring also includes a power supply circuit which will power those of its components that can be utilised in a

temperature monitoring system in accordance with the invention.

## CLAIMS:

1. A system for monitoring the condition of one or more refrigerated units, comprising sensing means adapted to provide a signal indicative of a temperature condition of the or each unit, a device having a primary function unrelated to the monitoring of refrigerated units, said device including at least a printer and a power supply circuit for developing the voltage or voltages needed for its primary function, and means for causing said device to be operable in a refrigeration information output mode in which the printer can print information derived from the signal or signals from the sensing means.

2. A system as claimed in claim 1 wherein said device includes a display which, in the refrigeration information output mode, can display information derived from the signal or signals from the sensing means.

3. A system as claimed in claim 1 or claim 2 wherein said device includes a keyboard which, in the refrigeration information output mode, is usable to initiate or control functions relating to the monitoring of the condition of said one or more

refrigerated units.

4. A system as claimed in any one of the preceding claims wherein said device includes a processor which can process information derived from the signal or signals from the sensing means.

5. A system as claimed in any one of the preceding claims wherein said device includes a memory which can store information derived from the signal or signals from the sensing means.

10 6. A system as claimed in any one of the preceding claims wherein said device includes a telecommunications output terminal which can be activated in response to information derived from the signal or signals from the sensing means.

15 7. A system as claimed in any one of the preceding claims in which said device is a cash register.

8. A system as claimed in any one of claims 1 to 6 in which said device is a weigh scale.

20 9. A system as claimed in any one of claims 1

to 6 in which said device is an IRCOC.

10. A system as claimed in any one of claims 1 to 6 in which said device is a facsimile machine.

11. A system as claimed in any preceding claim wherein the printer can print a log of the product temperatures of the refrigerated units.

12. A system as claimed in claim 4, or any of claims 5 to 11 when dependent on claim 4, wherein the processor computes the product temperatures of the refrigerated units.

13. A system as claimed in claim 5 or any one of claims 6 to 12 when dependent on claim 5, wherein the memory holds data representing the product temperatures of the refrigerated units.

14. A system as claimed in claim 4 or any of claims 5 to 13 when dependent on claim 4, wherein the processor detects when a temperature condition of a refrigerated unit is indicative of unsatisfactory operation of that unit.

15. A system as claimed in claim 14 when

dependent on claim 6 wherein the telecommunications output terminal is activated in response to said detection.

16. A system as claimed in any preceding claim  
5 wherein the device is provided with an alarm output facility which is activated when a temperature condition of a refrigerated unit is indicative of unsatisfactory operation of that unit.

17. A system as claimed in any one of the  
10 preceding claims, for monitoring the condition of one or more refrigerated units which are each provided with their own temperature control system which system contains one or more parameters used in the control of the unit, and comprising means for causing said device  
15 to be operable in a control parameter alteration mode in which an input facility (such as a keyboard) of the device is usable to alter a control parameter or parameters of each said unit.

18. A cash register, for use in a system as  
20 claimed in claim 1, and having at least a power supply circuit for developing the voltage or voltages needed for its operation as a cash register, and a printer, and equipped with auxiliary circuitry comprising



inputs adapted to receive signals from said sensing means, an alarm output facility, and means for switching the cash register between its primary cash register mode of operation and said refrigeration information output mode.

19. A cash register as claimed in claim 18 wherein the auxiliary circuitry further includes a processor and memory for use in monitoring the conditions of the refrigerated units.

10 20. A cash register as claimed in claim 18 or claim 19, wherein said auxiliary circuitry is provided as one or more units added to the cash register after manufacture.

15 21. A cash register as claimed in claim 18, wherein said auxiliary circuitry is included at the manufacturing stage.

22. One or more add-on units including the auxiliary circuitry for a cash register as claimed in claim 20.

20 23. A cash register substantially as hereinbefore described with reference to Figure 1 or

Figure 2 of the accompanying drawings.

24. A system for monitoring the conditions of one or more refrigerated units substantially as hereinbefore described with reference to Figure 1 or  
5 Figure 2 of the accompanying drawings.

-24-

**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

Application number 9025300.6

<b>Relevant Technical fields</b> (i) UK CI (Edition K ) G1N (NADC, NAHJ, NAJX, NARA)  (ii) Int CI (Edition 5 ) F25B, F25D, G01K  <b>Databases (see over)</b> (i) UK Patent Office  (ii) ONLINE DATABASES : WPI	<b>Search Examiner</b>  D J. MOBBS  <hr/> <b>Date of Search</b>  31.01.91.
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Documents considered relevant following a search in respect of claims 1-24

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	US 4482785 (FINNEGAN et al)	

SF2(p)

Category	Identity of document and relevant passages	Relevant to claim(s)

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